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Type Conversion of Electrodeposited Cuprous Oxide

L. D. R. D. Perera[1], W. Siripala[1], K. T. L. De Silva[2]and J. K. D. S. Jayanetti[2]
[1]Department of Physics, University of Kelaniya [2]Department of Physics, University of Colombo

Cuprous oxide is an inexpensive and non-toxic semiconductor material having a direct band gap of 2.0 eV. In view of its possible applications in low-cost solar energy converting devices thin films were fabricated and their crystallographic and optoelectronic properties were investigated using X-ray diffraction and spectral response measurements.

Thin films of polycrystalline cuprous oxide were electrodeposited on indium tin oxide (ITO) coated glass substrates using an aqueous electrolyte under potentiostatic conditions. The photo-response of both the as deposited and annealed samples were investigated. The films were used in a three electrode photoelectrochemical cell for spectral response measurements. The experimental set up consisted of a potentiostat, a lock-in-amplifier, a monochromator and a chopper.

At rest potential, the photoresponse of the as deposited Cu2O films illuminated through the Cu2O/electrolyte interface (front illumination) was n-type in the whole spectral range. When illuminated through the ITO substrate (back illumination) the photocurrent was p-type for shorter wave lengths and n-type for longer wave lengths. These results indicate the existence of two n-type Schottky barriers at the Cu2O/electrolyte interface and at the Cu2O/ITO interface, and show that electrodeposited Cu2O thin films behave as an n-type material in a PEC cell.

The samples were annealed in air and their XRD patterns were obtained as a function of annealing. No significant change in the XRD spectra could be observed for samples annealed at temperatures below 300 0C. for samples annealed at temperatures above 3000C, the XRD spectra showed peaks corresponding to CuO and its complexes with water. Also, heat treatments at higher temperatures resulted in darker films.

In both the cases of front and back illuminations, the photoresponses of Cu2O annealed at 200 0C was n-type in the whole spectral range. When compared with the spectral response of the as deposited samples, these observations suggest that the Schottky barrier at the Cu2O/ITO interface has been removed by annealing at 200 0C. The films annealed at 300 0C showed a p-type photocurrent in the entire spectral range on front illumination. This observation suggests that the conductivity type of Cu2O has changed from n-type to p-type upon annealing at 300 0C.